



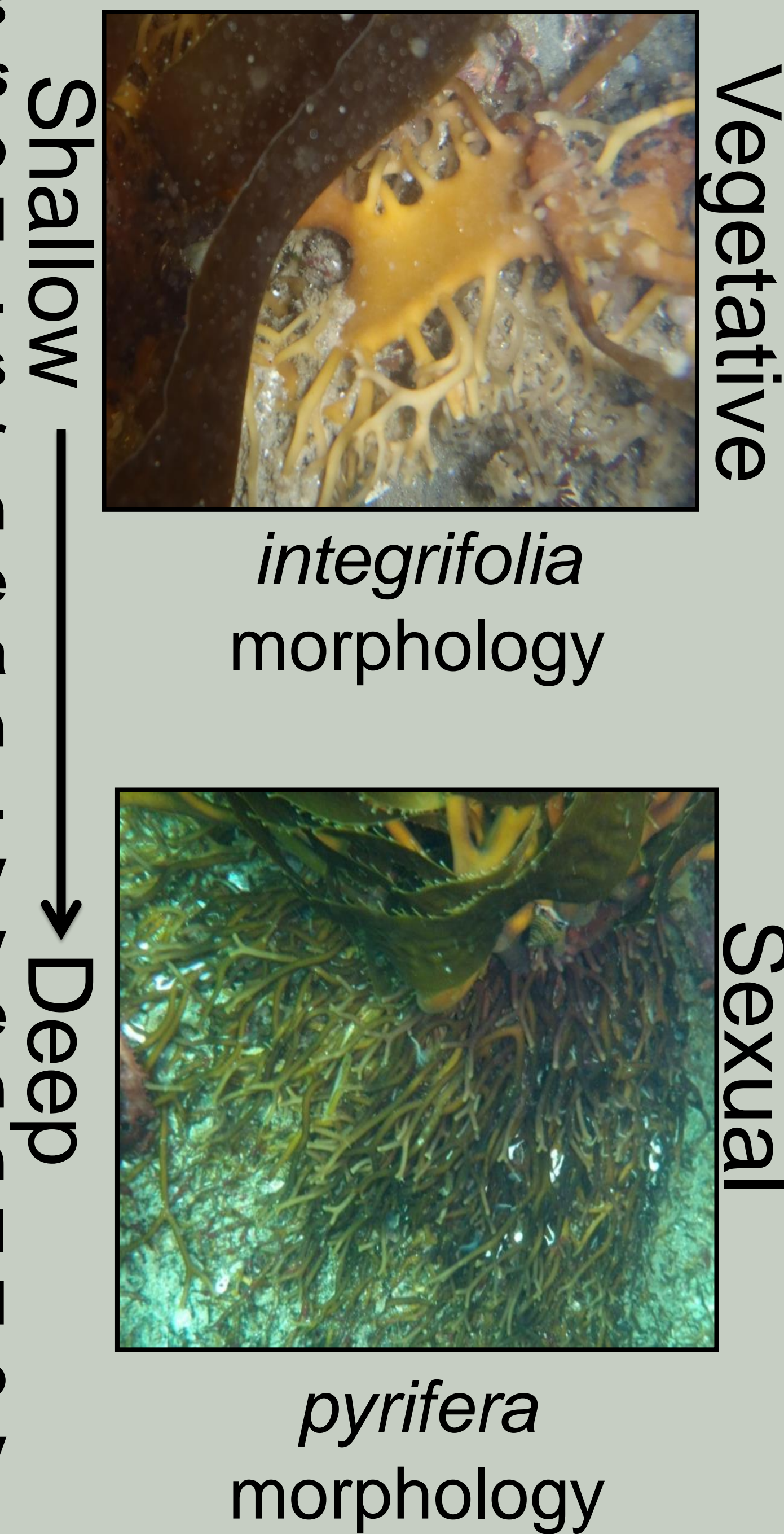
Depth regulates the sexual reproduction of a morphologically plastic kelp in central California

Sarah V. Jeffries

Moss Landing Marine Laboratories

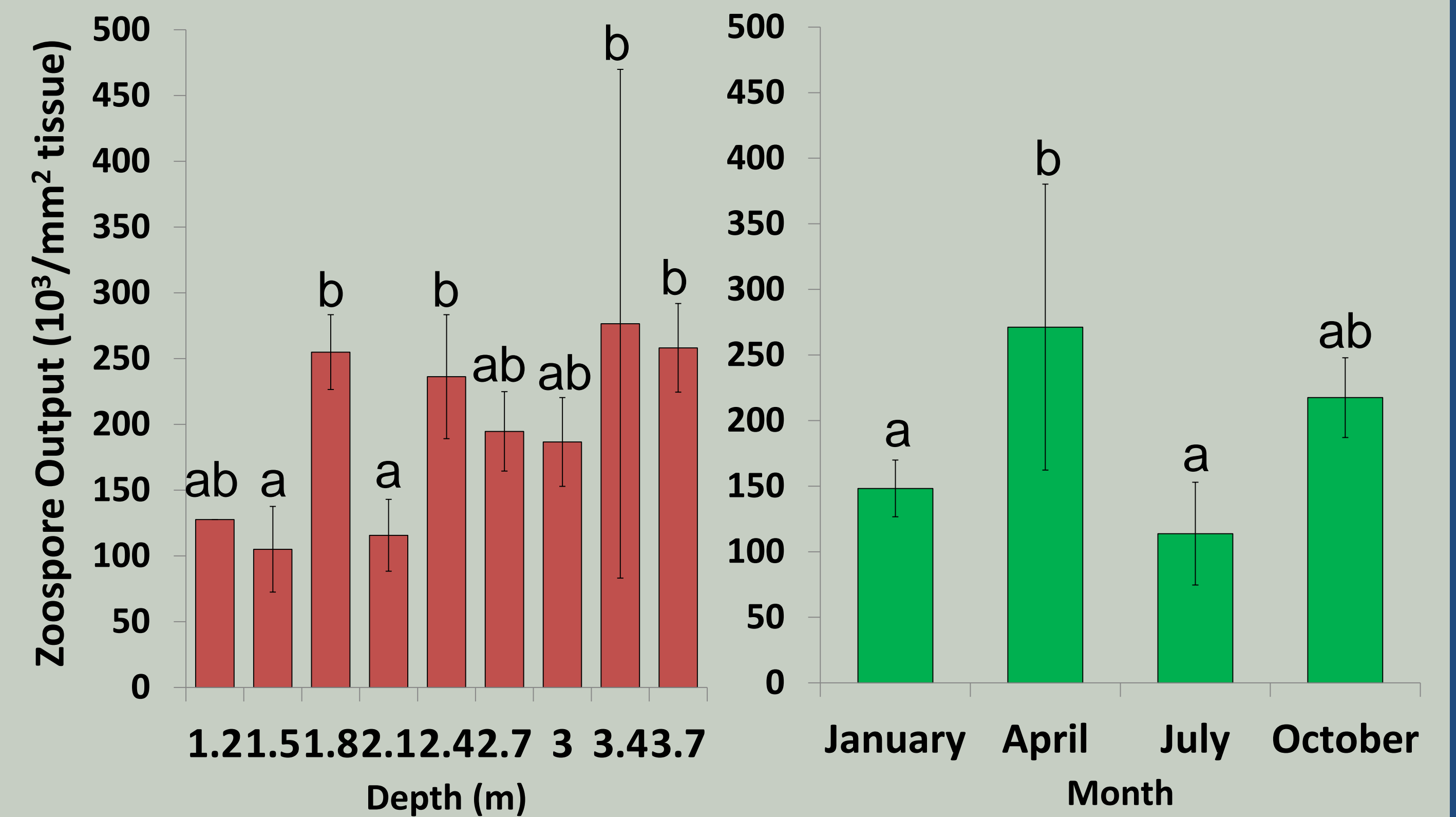
BACKGROUND

Until its recent synonymization (Demes et al. 2009), the kelp genus *Macrocystis* was considered to be separated into four species, three of which were based on holdfast morphology (Setchell, 1932). Two of these synonymized species occur locally and also vary in their reproductive mode. The *integrifolia* form grows vegetatively via a rhizome while the *pyrifera* form is characterized by a mounding holdfast and the production of sporophylls for sexual reproduction. These morphologies are stratified by depth: the sexual morphology generally occurs in water deeper than 3m and the vegetative morphology only occurs in shallow water (<3m) (Neushul, 1963). In this study, I conducted seasonal subtidal surveys in order to understand the effect of water depth on the extent to which sexual reproduction is utilized by *Macrocystis*.



RESULTS

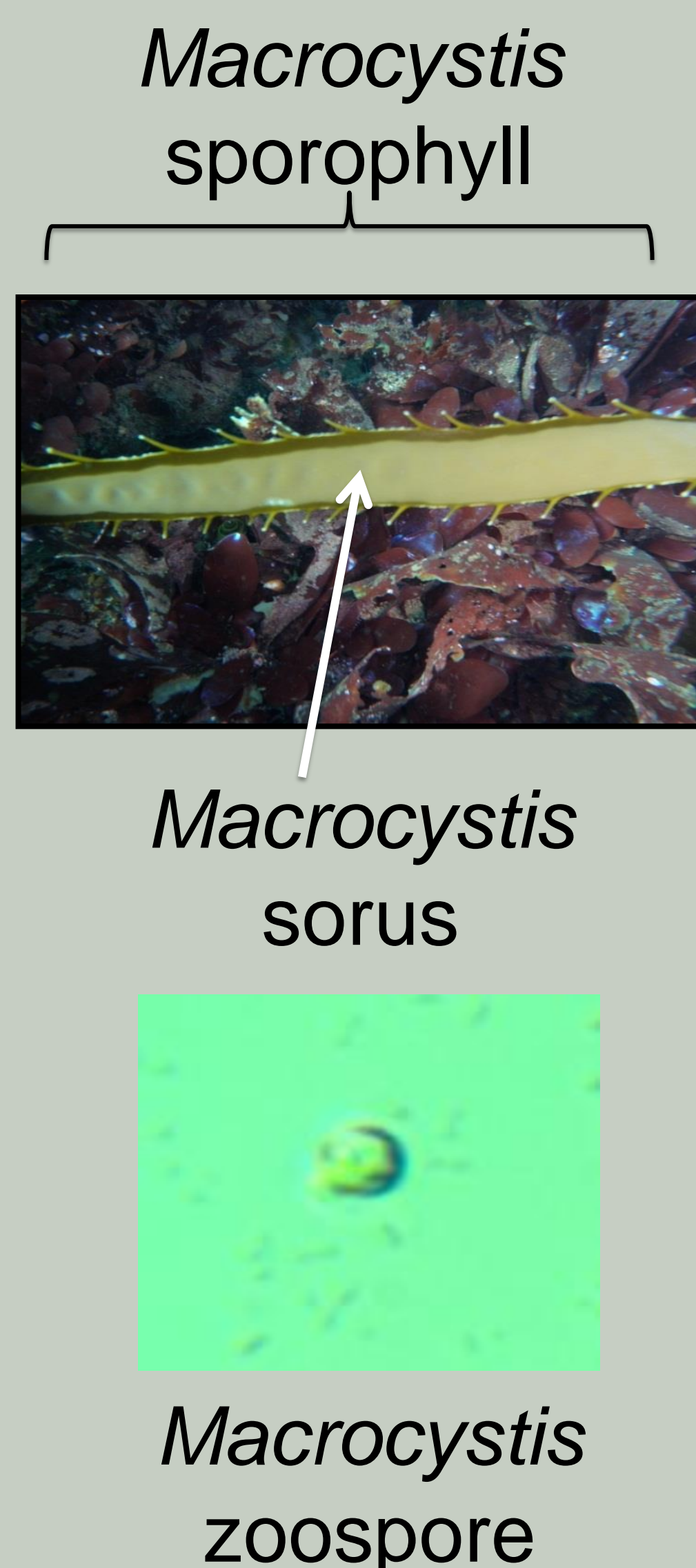
Sexual reproduction increases with depth and was highest in April and October



	df	Mean Square	F	p
Month	3	39372.345	3.378	.037
Depth	8	26683.236	2.289	.061
Month * Depth	10	21547.502	1.848	.113
Error	21	11657.079		

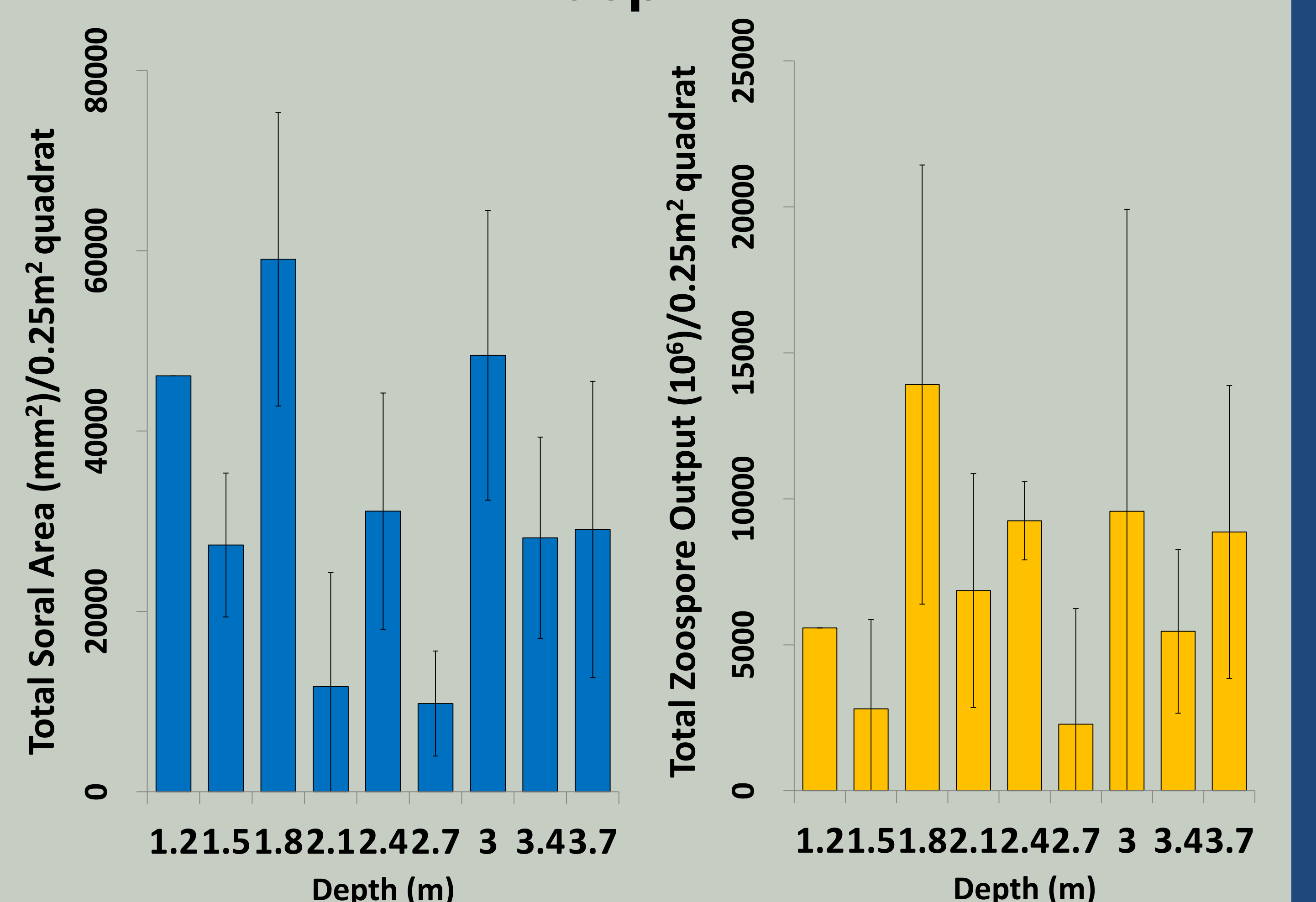
2-way ANOVA shows a significant effect of month and depth on zoospore output and an insignificant interaction between month and depth. Letters over the bars indicate significant differences (Fisher's LSD, $p < 0.1$).

METHODS



From January 2013 to January 2014, quarterly subtidal surveys were conducted in Stillwater Cove, California along a depth gradient from 1m to 4m encompassing both morphologies of *Macrocystis*. Material from all visibly reproductive individuals was collected within 1m of the transect using a 0.25m² quadrat as a proxy for an "individual." The depth of each sample was recorded. In the lab, each visible sori was measured for area, then three sori were randomly chosen for zoospore culturing. A punch was taken from each chosen sori and cultured for 24 hours when the zoospore output counts were made. These counts were averaged and standardized to represent sexual reproductive output (zoospores/mm² of sorus).

Total sexual reproduction not affected by depth



One-way ANOVA ($F_{8,34}=1.206$, $p=0.325$) One-way ANOVA ($F_{8,34}=0.898$, $p=0.529$)

CONCLUSIONS

These results show that *Macrocystis* sexual reproduction varies with month and increases with water depth. However, when reproduction was extrapolated to individuals, no depth effect was found on either total soral area or zoospore output. This discrepancy may be related to investment differences between the morphologies: *pyrifera* individuals may invest in fewer large sori with higher zoospore production while the *integrifolia* form invests in the production of many small sori, likely as a secondary reproductive strategy to vegetative growth of the rhizome. Future work will focus on the effect of depth on other reproductive investment metrics such as soral weight and percent cover and on morphological changes with depth. There have been very few studies which compare the morphologies of *Macrocystis* and integrative studies like these are needed to understand the relationship between these morphologies and their impacts on the nearshore environment.

References

Demes KW, Graham MH, Suskiewicz TS. 2009. Phenotypic plasticity reconciles incongruous molecular and morphological taxonomies: the Giant Kelp, *Macrocystis* (Laminariales, Phaeophyceae), is a monospecific genus. *Journal of Phycology* 45(6): 1266-1269. Neushul M. 1963. Studies on the giant kelp, *Macrocystis*. II. Reproduction. *American Journal of Botany* 50(4): 354-359. Setchell WA. 1932. *Macrocystis* and its holdfasts. *University of California Publications in Botany* 16(13): 445-492.

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